Cascadia Subduction Zone: Issues for Discussion by NEPEC

"C'mon, c'mon — it's either one or the other."

Evelyn Roeloffs, Joan Gomberg, John Vidale
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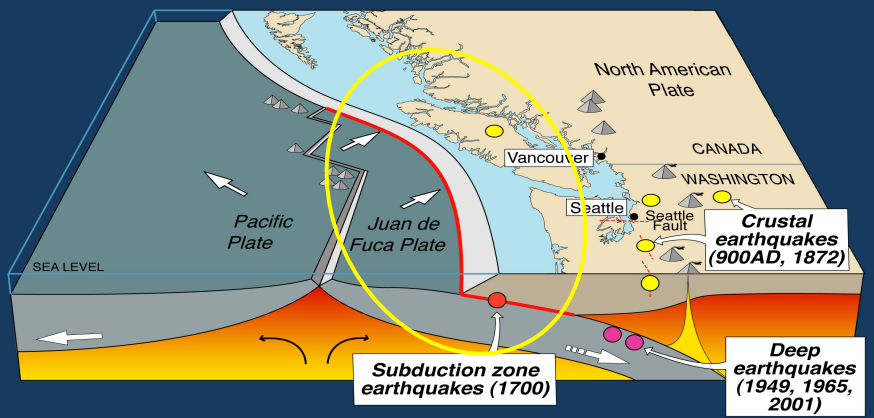
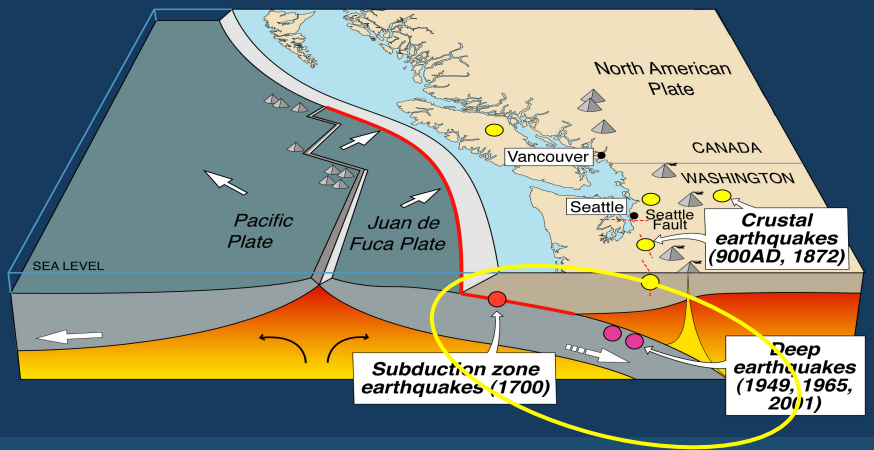
Cascadia earthquake sources



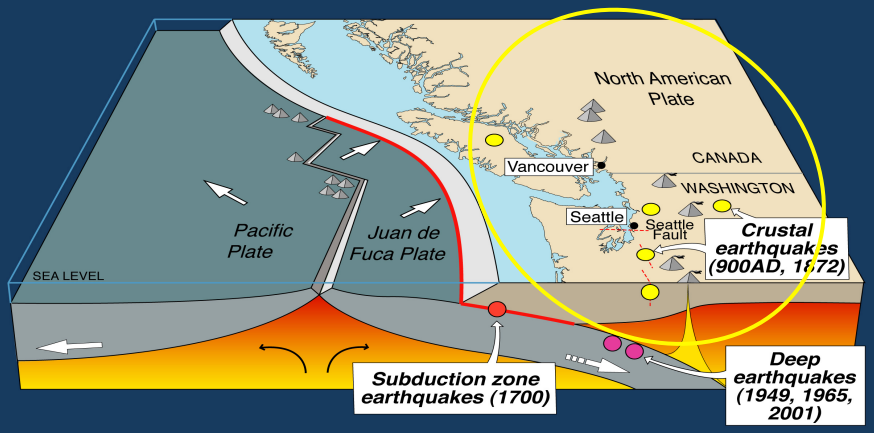
*Subduction zone earthquakes are the **Big Ones**, occurring where the downgoing plate is usually stuck. About 10% chance of **M9+ each 50 years.***

Cascadia earthquake sources



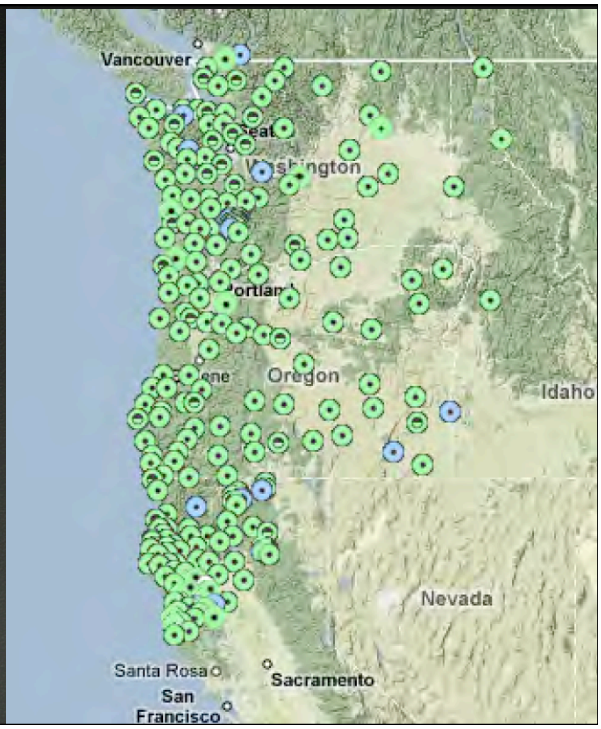
*'Intraplate' (deep) earthquakes have been moderate in size & deep, occurring as the plate flexes on its way down. **In a 50-year window, there's an 84% chance of an M6.5+ interplate earthquake.***

Cascadia earthquake sources

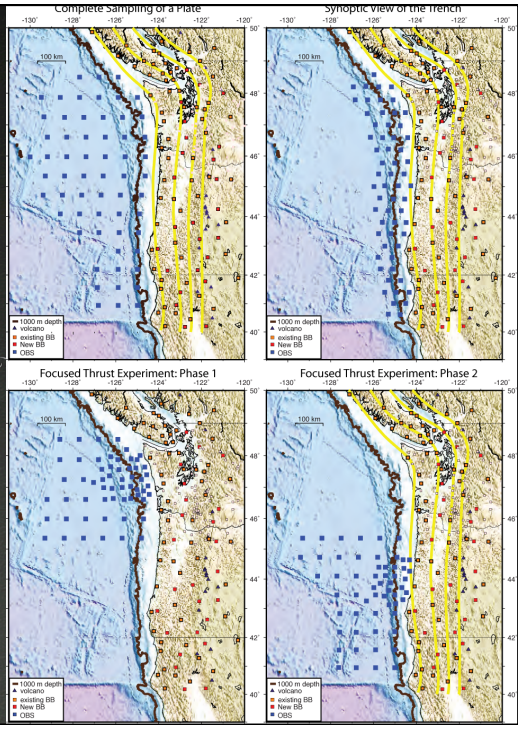


'Crustal' earthquakes** occur because **the crust is deforming**, as well as the subduction zone slipping and the plate flexing. **In a 50-year window, the chances are 5% & 15% of an M6.5+ earthquake on the Seattle fault & in the crust anywhere in the Puget Sound region, respectively.

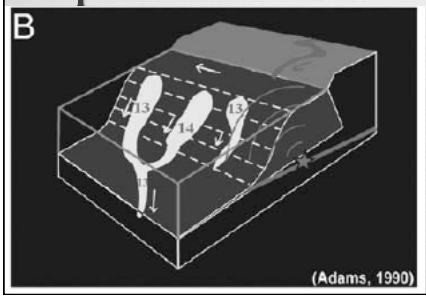
The future:
232 realtime, high sample-rate GPS stations!

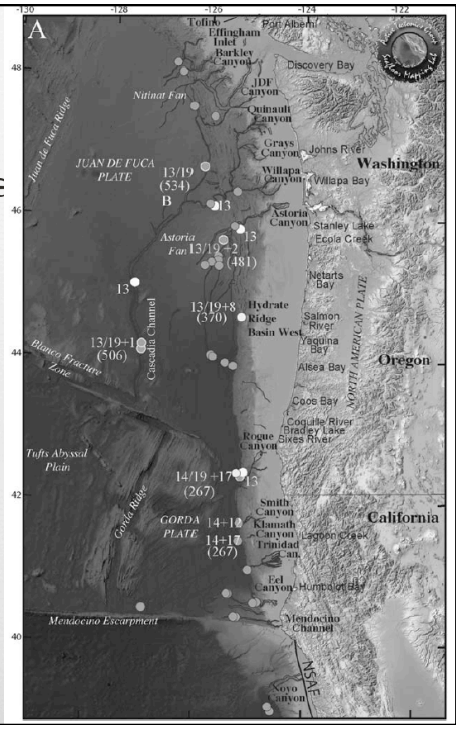


The future:
Seismic view of the ENTIRE subduction zone!



Cascadia paleoseismicity

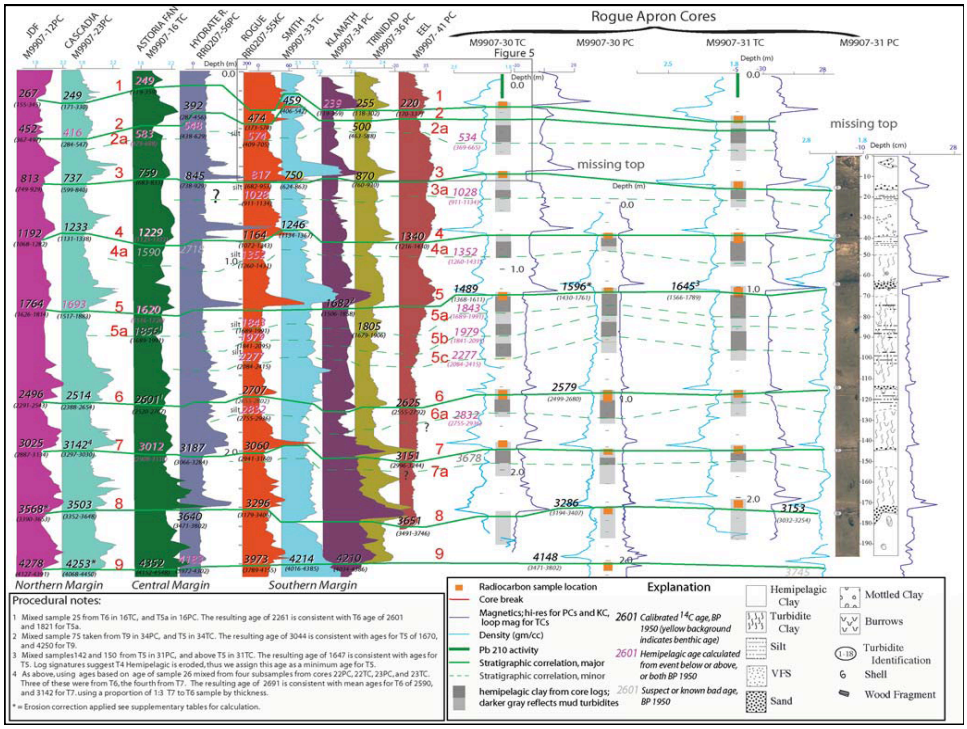




Coring

Details

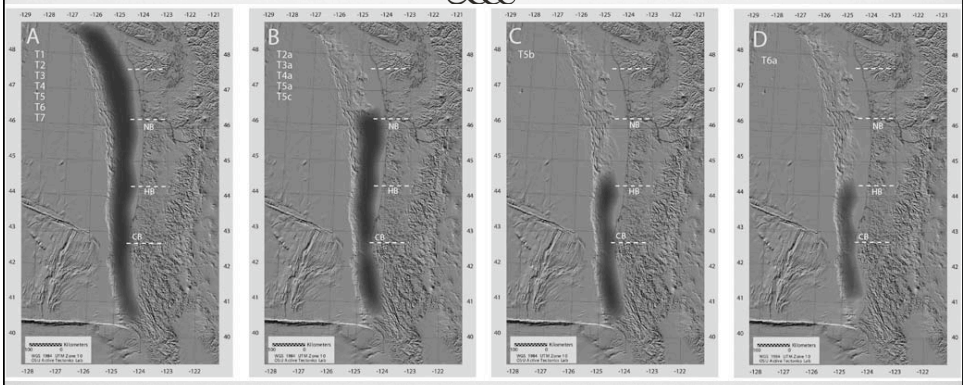
- Radiocarbon analysis of Planktic foraminifers in the sediment below turbidite
  - Organic content of turbidite difficult to identify
  - Bioturbation of turbidite may confuse sampling
  - Basal erosion issues?
- Issues: Storm loading, tsunami, storm discharge, bolide impacts, landslides



Cascadia rupture history

- 38 probable earthquakes in 10,000 years
  - Mean recurrence interval of 260 years
  - 215 years in the last 3000 years
- 19 events rupture full length
  - Recurrence every 496-524 years
- 17 rupture only southern margin
  - In three configurations
  - Northern limits to rupture at uplifts inferred to segment ETS - Nehalem, Heceta, and Coquille Banks
- 2 events rupture ¾ length

Variable rupture mode and ETS segmentation



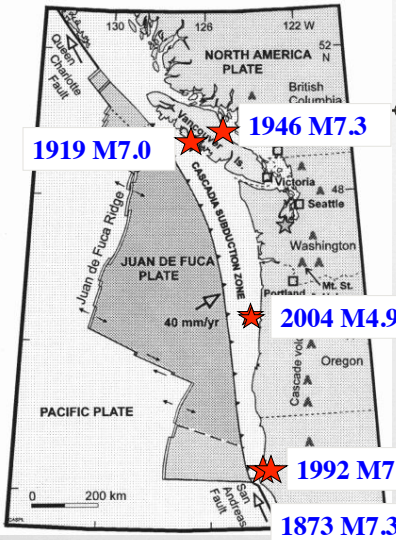
Megathrust quake *Science issues*

- *Many types of earthquakes complicates interactions*
  - *- crust, interface, intraslab, volcanoes*
- *intraslab statistics the least well-constrained*
- *how characteristic is M9 recurrence?*
- *Goldfinger great earthquake history*
  - *inferences – speculative or solid?*
- *most useful perspective is global survey for adequate statistics*

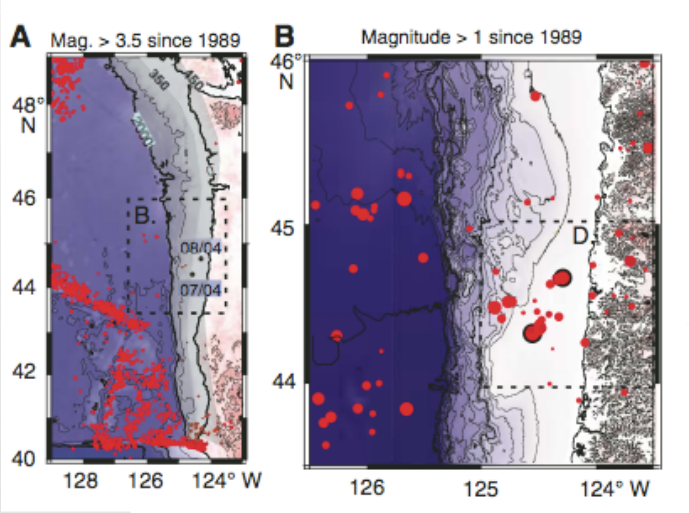
Cascadia Megathrust Sequences

- Megathrust ruptures won't all be a single event
  - M9 (NSHMP 67% weight) will have aftershocks, likely including M8 earthquakes
  - Several events M8-8.7 (NSHMP 33% weight), temporal evolution of sequence unknown
- Indicators that Cascadia event sizes vary:
  - Turbidite studies (Goldfinger et al.) shorter recurrence intervals (220 years) southern Oregon
  - various paleo indicators (Nelson et al.) find shorter recurrence intervals in southern Oregon

Cascadia Subduction Interface Seismicity



Pacific Geoscience Center, updated by ER



Trehu et al. Geology 2008

Cascadia Foreshock Issues

- Available data insufficient for robust statistics
- Limited ability to resolve exact nature of event
  - Depth to subducting slab uncertain in Oregon
  - Network coverage poor in southern Oregon
  - Very little offshore coverage
    - NSF Cascadia-MARGINS will fund OBS's, but no real-time data from them
- Current seismicity unrepresentative

Aseismic Deformation

- Aseismic deformation that differs from "business as usual"
  - Updip, i.e., closer to locked zone
  - Much larger
- Microfossil evidence suggests possible longer-term (years) pre-seismic coastal subsidence
- Published papers argue for aseismic slip preceding 1960 Chile earthquake and 1944 M8.1 Tonankai earthquake

Much work to define basis for possible advisories and implement detection algorithms

Cascadia Policy Challenges

- 3 states, 2 countries involved
  - OR and WA have no experience with earthquake "advisories"
- No single organization monitors seismicity
  - No one monitors GPS, tremor, strain in Cascadia yet
- Advisories could potentially arise from
  - Potential foreshocks
  - Accelerated aseismic slip

What we are doing

- We have informal buy-in from OR and WA Emergency Managers and State Geological surveys
- We will plan a workshop involving the Science side, and the Policy side, in the next few months
- Convene scientists to agree on, what is a situation of concern and to write pre-approved statements
  - Start with, seismic
  - Then, aseismic
- Seems necessary to convene an advisory body to include Canada and more regional experts

Joan

- ETS
- Swarms

Actionable items

- Workshop on assessing quake probabilities, particularly turbidite-derived estimates
- Determine means for determining what circumstances particular to Cascadia warrant public notification and how to deliver such messages. Cascadia subcommittee of NEPEC – PEPEC?
- Research and/or workshop on hazard implications of swarms
- Sharpen research focus on earthquake sequence (aftershock, etc.) probabilities